UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/721,100	11/26/2003	Gerhard Guenter Theodor Kramer	29250-001076/US	6192

7590 09/19/2007

HARNESS, DICKEY & PIERCE, P.L.C.
P.O. Box 8910
Reston, VA 20195

EXAMINER	
WILLIAMS, LAWRENCE B	

ART UNIT	PAPER NUMBER
2611	

MAIL DATE	DELIVERY MODE
09/19/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/721,100	KRAMER ET AL.	
	Examiner	Art Unit	
	Lawrence B. Williams	2611	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 05 July 2007.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-20 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-6,12-13,20 is/are rejected.

7)☒ Claim(s) 7-11,14 and 16-19 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments filed 05 July 2007 have been fully considered but they are not persuasive. Applicant argues that Jin et al. fails to disclose, teach or suggest check-biregular nonsystematic repeat-accumulate codes. The examiner respectfully disagrees. Jin et al. discloses nonsystematic repeat accumulate code as one type of IRA (irregular repeat-accumulate) codes (col. 4, lines 13-15). Applicant discloses biregular referring to the check nodes having a degree of 1 or d_c (pg. 9, lines 8-11). Though Jin et al. does not use the term "birgegular, Jin et al. discloses regular repeat accumulate codes with check nodes having a degree of (i + 2) which is equivalent to applicant's claimed $\mathbf{d_c}$ (col. 4, lines 37-47). Thus Jin et al. discloses the check-biregular nonsystematic repeat-accumulate codes in his invention. As for Jin et al. being silent regarding mapping, applicant is referred to col. 6, lines 12-20, wherein Jin et al. teaches mapping.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 1, 3-5, 20 are rejected under 35 U.S.C. 102(e) as being anticipated by Jin et al. (US Patent 7,116,710 B1).

(1) With regard to claim 1, Jin et al. discloses in Fig(s) 2, 4, a method of transmitting data in a communication system, comprising the steps of: encoding bits (Fig. 2, outer and inner encoders, 202, 206) of a data stream with check-biregular nonsystematic repeat-accumulate codes (col. 4, lines 37-47). Applicant discloses biregular referring to the check nodes having a degree of 1 or d_c (pg. 9, lines 8-11). Though Jin et al. does not use the term "birgegular, Jin et al. discloses regular repeat accumulate codes with check nodes having a degree of (i + 2) which is equivalent to applicant's claimed $\mathbf{d_c}$ (col. 4, lines 37-47). Thus Jin et al. discloses the invention with check-biregular nonsystematic repeat-accumulate codes, and mapping the encoded bits to a signal for transmission (col. 6, lines 12-20).

(2) With regard to claim 3, Jin et al. also discloses in Fig. 2, the method of claim 1, wherein the encoding step includes: first encoding bits of the data stream with repetition codes (element 202) to obtain first encoded bits (col. 2, lines 50-54); re-ordering (element 204) a bit order of the first encoded bits based on an interleaving process (col. 3, lines 17-21); second encoding the re-ordered first encoded bits with parity check codes to obtain second encoded bits (col. 3, lines 17-50); accumulating (element 206) the second encoded bits to obtain nonsystematic repeat-accumulate coded bits (col. 2, lines 65-67).

(3) With regard to claim 4, Jin et al. also discloses a method of decoding data in a communication system, comprising the steps of: detecting one or more transmitted signals of a data stream encoded with check-biregular, nonsystematic repeat-accumulate codes to obtain a detection output; and decoding the detection output to obtain a decoded stream of bits for reconstructing the data stream (col. 5, lines 32-45). Applicant discloses biregular referring to the check nodes having a degree of 1 or d_c (pg. 9, lines 8-11). Though Jin et al. does not use the term

"birgegular, Jin et al. discloses regular repeat accumulate codes with check nodes having a degree of (i + 2) which is equivalent to applicant's claimed $\mathbf{d_c}$ (col. 4, lines 37-47).

(4) With regard to claim 5, Jin et al. also discloses the method of claim 4, wherein the detection output is a plurality of channel reliability values representing nonsystematic repeat-accumulate coded bits of at least one of the transmitted signals (col. 5, lines 1-12, 35-40). Jin et al. discloses in these passages the detection output representing probability densities, which are in fact the same as applicant's reliability values.

(5) With regard to claim 20, Jin et al. discloses in Fig(s). 2, 4, a modulation and coding scheme for a communication system (col. 4, lines 37-47), the modulation and coding scheme based on the use of check-biregular nonsystematic repeat-accumulate codes for encoding channel information for transmission (Applicant discloses biregular referring to the check nodes having a degree of 1 or d_c (pg. 9, lines 8-11). Though Jin et al. does not use the term "birgegular, Jin et al. discloses regular repeat accumulate codes with check nodes having a degree of (i + 2) which is equivalent to applicant's claimed $\mathbf{d_c}$ (col. 4, lines 37-47). Thus Jin et al. discloses the invention with check-biregular nonsystematic repeat-accumulate codes and employing a combined detection and decoding arrangement to decode the coded channel information (col. 5, lines 1-45).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over by Jin et al. (US Patent 7,116,710 B1) as applied to claim 1 above, and further in view of Walton et al. (US 2004/0081073 A1).

As noted above, Jin et al. discloses substantially all the limitations of claim 1 above. Furthermore, Jin et al. also discloses in Fig. 2, the method of claim 1, wherein the encoding step includes: first encoding bits of the data stream with repetition codes (element 202) to obtain first encoded bits (col. 2, lines 50-54); re-ordering (element 204) a bit order of the first encoded bits based on an interleaving process (col. 3, lines 17-21); second encoding the re-ordered first encoded bits with parity check codes to obtain second encoded bits (col. 3, lines 17-50); accumulating (element 206) the second encoded bits to obtain nonsystematic repeat-accumulate coded bits (col. 2, lines 65-67).

Jin et al. does not explictly disclose subjecting the nonsystematic repeat-accumulate coded bits to an interleaving process prior to the mapping step for facilitating decoding of the transmitted signal when received at a receiver.

However, interleaving encoded bits prior to mapping is a well-known technique in the art. Walton et al. discloses in Fig. 2, a bit encoder (216) supplying bits to a repeat/puncture device (218) wherein the bits are then supplied to a channel interleaver (220) prior to mapping (220).

Thus the step of subjecting the nonsystematic repeat-accumulate codes to an interleaving process prior to mapping is well-known in the art and one would have been motivated to use the known technique as a method of preventing error propagation in the system by providing time, frequency, and/or spatial diversity for the encoded bits.

6. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jin et al. (US Patent 7,116,710 B1) as applied to claim 5 above, and further in view of Woerz et al. (Iterative Decoding for Multilevel Codes Using Reliability Information).

As noted above, Jin et al. discloses substantially all limitations of claim 5. Jin et al. does not teach the method of claim 5, wherein the decoding step includes: first decoding the plurality of reliability values to obtain a first output; and second decoding the first output to obtain a second output; and third decoding the second output to obtain a third output that is fed back for the second decoding and then the first decoding to complete a decoding iteration that provides decoding information for a next decoding iteration.

However, Woerz et al. teaches an iterative decoding method in Fig. 2, wherein he discloses first decoding the plurality of reliability values to obtain a first output; and second decoding the first output to obtain a second output; and third decoding the second output to obtain a third output that is fed back for the second decoding and then the first decoding to complete a decoding iteration that provides decoding information for a next decoding iteration (pg. 1781-1782, 3.2 Use of Reliability Information and 3.3 Use of Decoding Iterations).

One skilled in the art would have been motivated to incorporate the teachings of Woerz et al. to increase the signal-to-noise ration of the system (abstract).

7. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jin et al. (US Patent 6,985,536 B2) in view of Woerz et al. Iterative Decoding for Multilevel Codes Using Reliability Information as applied to claim 6 above, and further in view of Ashikhmin et al. (US 2004/0002309 A1).

As noted above, the combination of Jin et al. and Woerz et al. disclose substantially all limitations of claim 6, above. They do not however teach, wherein the first, second and third outputs are modeled in advance, each by a corresponding transfer characteristic curve that accounts for the nonsystematic repeat-accumulate codes for at least one transmitted signal, and the transfer characteristic curve modeling the third output is fit to the transfer characteristic curves of one or both of the first and second outputs to facilitate decoding the transmitted signals at a highest possible data rate with a lowest possible bit error rate.

However, Ashikhmin et al. teaches a MIMO system having a channel decoder matched to a MIMO detector wherein he teaches first, second and third outputs are modeled in advance, each by a corresponding transfer characteristic curve that accounts for LDPCC codes (pg. 2, paragraph [0009]) codes for at least one transmitted signal, and the transfer characteristic curve modeling the third output is fit to the transfer characteristic curves of one or both of the first and second outputs to facilitate decoding the transmitted signals at a highest possible data rate with a lowest possible bit error rate. Ashikhmin et al. discloses selection of degrees for the CND, (Fig. 6. 720, corresponding to a third output, VND (Fig. 6, element 710, corresponding to a second output) such that the transfer characteristic curve of CND is matched to the transfer characteristic curve of the MIMO detector (Fig. 2, 150, corresponding to a first output) and the VND, element 710. (pg. 5, paragraph [0043]). Ashikhmin et al. models characteristic curves of the outputs by selecting in advance a signal-to-noise, to determine a characteristic curve of the MIMO detector and then selects degrees of the CND and VND to determine their characteristic curve (pg. 6, paragraph [0046]). Ashikhmin et al. also discloses the invention to facilitate decoding with a lowest possible bit error rate (pg. 2, paragraph [008]).

Though Ashikhmin et al. teaches a different code, it would have been obvious to one skilled in the art to incorporate the teachings of Ashikhmin et al. as a method of reducing the bit error rate in the system (pg. 2, paragraph [0009]).

8. Claims 13, 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jin et al. (US Patent 7,116,710 B1) in view of Ashikhmin et al. (US Patent 2004/0002309 A1).

(1) With regard to claim 13, Jin et al. discloses a detector/decoder arrangement for a receiver in a communication system, comprising a detector for performing a bit detection of a data stream (col. 5, lines 32-45) including check-biregular, nonsystematic repeat-accumulate codes (col. 4, lines 37-47). Applicant discloses biregular referring to the check nodes having a degree of 1 or d_c (pg. 9, lines 8-11). Though Jin et al. does not use the term "biregular, Jin et al. discloses regular repeat accumulate codes with check nodes having a degree of (i + 2) which is equivalent to applicant's claimed $\mathbf{d_c}$ (col. 4, lines 37-47). Thus codes detected would be check-biregular nonsystematic repeat-accumulate codes. Jin et al. does not give a full detail of the detector/decoder arrangement.

However, Ashikhmin et al. discloses a combined detector/decoder arrangement (655) for a receiver in a communication system, comprising: a detector (MIMO Detector, 150) for performing a bit detection from channel information received on one or more channels to provide a detector output; a first node decoder (610) for determining extrinsic values from the detector output for use as a priori knowledge by the detector for a next bit detection iteration (see Fig. 4), and for outputting reliability values (pg. 4, paragraph [0035]), wherein the detector and first node decoder are represented by a first transfer characteristic curve (pg. 4, paragraph [0033]); and a

second node decoder (CND, 720) for determining modified reliability values from the received reliability values (pg. 4, paragraph [0035]), wherein the second node decoder (CND, 720) is represented by a second transfer characteristic curve adapted so as to substantially match the first transfer characteristic curve (pg. 5, paragraph [0041]).

It would have been obvious to one skilled in the art at the time of invention to incorporate the teachings of Ashikhmin et al. as a method of reducing the bit error rate of decoded signals based on the transfer characteristics of the channel decoder (Pg. 1, paragraph [006]).

(2) Regarding claim 15, Ashikhmin et al. also discloses the arrangement of claim 13, wherein the detector includes: an inner detection loop having a multiple-input, multiple output (MIMO) detection portion for performing a posteriori probability bit detection on the received channel information to output soft bits to the first node decoder, and an accumulator decoder (Fig. 6, 730) to perform an a posteriori probability decoding process to feedback a priori knowledge to the detection portion for a next bit detection iteration at the detection portion (pg. 5, paragraphs [0041-0042]).

It would have been obvious to one skilled in the art at the time of invention to incorporate the teachings of Ashikhmin et al. as a method of reducing the bit error rate of decoded signals based on the transfer characteristics of the channel decoder (Pg. 1, paragraph [006]).

Allowable Subject Matter

9. Claims 7-11 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

10. Claims 14, 16-19 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, 2nd paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

11. The following is a statement of reasons for the indication of allowable subject matter: the instant application discloses a method of transmitting and decoding data in a communication system. A search of prior art records has failed to disclose a method of transmitting data in a communication system:

"wherein the first decoding step further includes performing an a posteriori probability decoding process to obtain the first output, the first output is a first set of log-likelihood ratio values representing partially decoded bits from decoding nonsystematic repeat-accumulate encoded bits of at least one of the transmitted signals, so that the partially decoded bits reflect bits of the data stream that have been subject only to repetition encoding and parity-check encoding at a receiver" as disclosed in claim 7.

"the arrangement of claim 13, wherein the detector performs MIMO trellis detection on the received channel information for providing soft bits to the first node decoder, and an accumulator decoder to feedback a priori knowledge for a next MIMO trellis detection iteration" as disclosed in claim 16.

"the arrangement of claim 13, wherein the detector output represents channel reliability values for a nonsystematic repeat-accumulate coded bit-stream, and the first node decoder is a combination of an accumulator decoder and a check node decoder that includes a check node

layer having a small fraction of degree one check nodes to decode the nonsystematic repeat-accumulate coded bit-stream" as disclosed in claim 17.

"the arrangement of claim 13, wherein the second node decoder is a variable node decoder comprising k variable nodes to decode bits of the reliability values received from the first node decoder, wherein the modified reliability values output from the variable node decoder reflect completely decoded bits of the channel information" as disclosed in claim 19.

Conclusion

12. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lawrence B Williams whose telephone number is 571-272-3037. The examiner can normally be reached on Monday-Friday (8:00-6:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ghayour Mohammad can be reached on 571-272-3021. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Lawrence B. Williams
lbw
September 9, 2007

MOHAMMED GHAYOUR
SUPERVISORY PATENT EXAMINER